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PLUME CHARACTERIZATION ON THE IGUANA TEST SERIES

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ABSTRACT

We have performed measurements to characterize the spatial profile of chemical concentrations within the plume produced by the RSTR chemical release source. An open-air calibration volume (cell) is produced by the exhaust plume of the LGFSTF wind tunnel at NTS. The approximate diameter of the calibrated volume is 2 m, and the cell length is 6-8 meters.

On two of the IGUANA test releases where the planned release rate was to remain constant, we determined the plume profile by scanning NDIR gas analyzer probes horizontally in the plane of the downwind end of the diagnostics frame assembly. To obtain unambiguous data, both the chemical release rate and the external winds must remain constant for a sufficiently long time to get accurate plume profile concentration measurements. A polynomial fit to the measured concentration vs. position on the IGUANA 17 test resulted in a FWHM of 1.72 meters. Using a simple model of the plume concentration, we obtain a concentration FWHM for the laser user's line-of-sight (the "sweet spot") of 1.90 m and a concentration edge-to-edge distance of 2.46 m.

For each of the 11 tests which had good FTIR data, a rough comparison of the plume concentration (ppm) calculated from the measured chemical mass flow rate and the measured wind tunnel air flow rate, with the FTIR measurements (ppm-m) was made. This yields an inferred FTIR path length which ranged from 3.1 to 4.4 meters, with an average of 3.62±0.37 meters. The 1.9 meter FWHM value above together with the simplest triangular edge model for the plume profile gives a 2-pass path length at the position of the FTIR beams (assuming circular symmetry of the plume) of 3.8 meters. The 3.8 meters is an upper limit since all real processes will degrade (vs. enhance) the concentration. The agreement is actually pretty good, and suggests that for tests where the wind is consistently down the centerline, direct, quantitative comparisons with either or both the FTIR and calculated average plume concentrations should determine the ground truth for the laser experimenters to within the order of 10-30%.

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